

Commentary Commentaire

Ethics and euthanasia

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The death of an animal at human hands, be it a companion animal, food animal, or research animal, is an important element of an animal's welfare. Aristotle pointed out, with regard to humans, "count no man happy until he is dead." This is easy to understand with regard to human life, for the circumstances of one's death can considerably alter one's gestalt on everything else in life that has come before. Consider, for example, a man on his deathbed, who overhears what he thought was his loving wife for 40 years, say to another man, "I can't wait until the old bastard is gone. Then we can at last be together on his money." In that instant, what he thought was a good life is suddenly transfigured into a nightmare. Or, as an alternative example, imagine a Jewish citizen of Germany who served as a hero in World War I and as a pillar of the community, suddenly rousted by the Nazis, dragged to a concentration camp, and executed. Again, his life's history is colored irrevocably and negatively by the nature of his death.

In the case of an animal, the nature of its life seems at first blush different. After all, as Heidegger points out, a human being's life is futural in orientation, defined by goal-directed futural projects such as getting one's degree, seeing one's children graduate, finishing one's novel, and so on, all of which require the ability to think about long-term futural and possible events. This, in turn, requires a language and its syntax, which allow a linguistic being to think in counterfactual terms — "I will meet you in the park, but if the weather is foul, I will meet you in the restaurant," universal terms, "all black widow spiders are dangerous," possible terms, "my book might garner critical acclaim," or negative terms, "there are no unicorns in the library," or in combinations of these. Animals, lacking language, seem to be unable to think in that way. For these reasons, it is widely believed that ending an animal's life painlessly doesn't harm the animal — one is not aborting its life's goal or project. One has treated an animal well if one has given it a life consisting of pleasant "nows." For these reasons, many people, including myself, have argued that involuntary euthanasia is not only permissible for suffering animals, but indeed obligatory. Lacking hope, because hope requires futurally oriented concepts, an animal that lives in the now becomes its suffering, while a human

can anticipate modalities for relief, or look forward to fulfilling his or her futural life-defining goal.

On the other hand, it appears that Aristotle's point about how life ends could apply to an animal. Imagine a faithful dog, accustomed to love, being beaten to death by its master. In addition to the physical pain involved, there must also be emotional pain growing out of the dissonance between the animal's past and what it currently experiences. (We have of course every reason to believe animals can remember.) Thus, I feel comfortable suggesting that end-of-life experiences may have special significance to animals as well, since they color the sum total of the animal's previous experiences. A painful or stressful death may eclipse or negatively color all that came before. At least we can suggest that something like this insight underlays the high degree of human concern about how an animal dies, since the actual death is usually only a tiny fraction of the animal's life.

It is important to realize that we cannot be absolutely certain of the claim that animals do not anticipate the future. In fact, it seems obvious that they definitely anticipate the short-term future, as when a cat waits outside a mouse hole or a lion intercepts a gazelle. Anticipating the long-term future seems more problematic for the reasons given above, but it is far from clear where one draws the line between short and long term, and thus we may well be aborting future projects when we kill an animal.

If pressed to do so, I would make the distinction between an animal's ability to anticipate the short-term future versus the long-term future as follows: cases like the cat's anticipatory waiting outside the mouse hole can be explained by reference to innate or hard-wired predatory tendencies, which are given real-world content by the animal's experience. That is to say, the cat has had one or many associative experiences of mice emerging from holes, so the next time it expects another mouse. On the other hand, it cannot anticipate the end of life or playing with its as yet unborn grandchild, since it has experienced neither and lacks the linguistic capability discussed above.

I invoke this element of doubt to provide yet another reason we must address euthanasia as a social-ethical issue. It is evident that society is very much concerned about how an animal's life is ended. A few years ago, I received the following query from the *The Canadian Veterinary Journal* for me to address in the monthly column I have written for the *Journal* since 1990.

Why does society [demand] scrupulous rules to prevent relatively momentary suffering in animals being killed for food and research, while overlooking the much greater suffering that the same animals may experience in life if they are food or research animals?

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My reply was in part as follows:

Given our uncertainty about death, we approach it with profound concern. I recall team-teaching a course in the proper use of laboratory animals. One week, we taught euthanasia, using animals (rats) that needed to die for a research protocol. I recall the profound experience of uncertainty and regret I experienced when my colleague injected them with pentobarbital, and I watched the little life-flame flicker and die. I recall feeling “Who am I to do this, given the struggle these little creatures had engaged in to survive?” My only consolation, for want of a better word, was that they went to sleep peacefully, unaware that what they struggled to preserve had ended.

It is important to us that the summation, or consummation, of their lives not involve fear, horror, pain, or suffering as the final encapsulation of their lives, particularly given that we cannot provide compensation or remedy after death. The finality of killing makes us tread lightly.

Concern for these last moments is, in my view, an affirmation of decency in the face of inflicting irreversible termination of the creatures whose lives seem to be metaphysically their own, not ours to dispose of. This is a primordial emotion, more primordial than the reflective thought required to worry about how they live. One can hope that society will continue to develop its reflective concern about how we in fact make these animals expend their lives.

Plainly, society has evidenced an ever-increasing awareness of animal welfare for animals in all areas of human use, most recently agricultural animals — for example, 2008’s Proposition 2 in California, overwhelmingly passed by voters, that banned battery cages, veal crates, and gestation stalls; Colorado’s law, SB 201 of May 2008 eliminating gestation crates and veal crates; the Arizona and Florida referenda abolishing sow stalls; and the Oregon law doing the same. Unfortunately, US organized veterinary medicine, like the US agricultural industry, simply does not understand the concept of animal welfare, and correlatively, the concept of euthanasia, since euthanasia (that is, how an animal dies) is surely one aspect of its welfare.

When one discusses animal welfare with industry groups or with the American Veterinary Medical Association, one finds the same response — animal welfare is solely a matter of “sound science.” Those of us serving on the Pew Commission, better known as the National Commission on Industrial Farm Animal Production, encountered this response regularly during our dealings with industry representatives. This commission studied intensive animal agriculture in the US (1). One representative of the National Pork Producers, testifying before the Commission, affirmed that while people in her industry were quite “nervous” about the Commission, their anxiety would be allayed were we to base all of our conclusions and recommendations on “sound science.” Hoping to rectify the error in that comment, as well as educate the numerous industry representatives present, I responded to her as follows: “Madam, if we on the Commission were asking the question of how to raise swine in confinement,

science could certainly answer that question for us. But that is not the question the Commission, or society, is asking. What we are asking is, ought we to raise swine in confinement? And to this question, science is not relevant.” Judging by her puzzled response, “huh?”, I assume I did not make my point.

Questions of animal welfare are at least partly “ought” questions, questions of ethical obligation. The concept of animal welfare is an ethical concept to which, once understood, science brings relevant data. When we ask about an animal’s welfare under humanly imposed conditions, we are asking about what we owe the animal, and to what extent. When a document called the CAST (Council on Agricultural Science and Technology) report, first published by US agricultural scientists in the early 1980s, discussed animal welfare, it affirmed that the necessary and sufficient conditions for attributing positive welfare to an animal were represented by the animal’s productivity. A productive animal enjoyed positive welfare; a non-productive animal enjoyed poor welfare (2).

This notion was fraught with many difficulties. First of all, productivity is an economic notion predicated of a whole operation; welfare is predicated of individual animals. An operation such as caged laying hens may be quite profitable if the cages are severely overcrowded; yet the individual hens do not enjoy good welfare. Second, as we shall see, equating productivity and welfare is, to some significant extent, legitimate under husbandry conditions, where the producer does well if and only if the animals do well, and square pegs, as it were, are fitted into square holes with as little friction as possible (as when pigs live outside). Under industrial conditions, however, animals do not naturally fit in the niche or environment in which they are kept, and are subjected to “technological sanders” that allow for producers to force square pegs into round holes — antibiotics, feed additives, hormones, air handling systems — so the animals do not die and produce more and more kilograms of meat or milk. Without these technologies, the animals could not be productive. We will return to the contrast between husbandry and industrial approaches to animal agriculture.

The key point to recall here is that even if the CAST Report definition of animal welfare did not suffer from the difficulties we outlined, it is still an ethical concept. It essentially says “what we owe animals and to what extent is simply what it takes to get them to create profit.” This in turn would imply that the animals are well-off if they have only food, water, and shelter, something the industry has sometimes asserted. Even in the early 1980s, however, there were animal advocates and others who would take a very different ethical stance on what we owe farm animals. Indeed, the famous “five freedoms” articulated in Britain by the Farm Animal Welfare Council (3) during the 1970s (even before the CAST Report) represents quite a different ethical view of what we owe animals, when it affirms that:

The welfare of an animal includes its physical and mental state and we consider that good animal welfare implies both fitness and a sense of well-being. Any animal kept by man, must at least, be protected from unnecessary suffering.

We believe that an animal’s welfare, whether on farm, in transit, at market or at a place of slaughter should be considered in terms of “**five freedoms:**”

1. **Freedom from Hunger and Thirst** — by ready access to fresh water and a diet to maintain full health and vigor.
2. **Freedom from Discomfort** — by providing an appropriate environment including shelter and a comfortable resting area.
3. **Freedom from Pain, Injury or Disease** — by prevention or rapid diagnosis and treatment.
4. **Freedom to Express Normal Behavior** — by providing sufficient space, proper facilities and company of the animal's own kind.
5. **Freedom from Fear and Distress** — by ensuring conditions and treatment which avoid mental suffering.

Clearly, the two definitions contain very different notions of our moral obligation to animals (and there is an indefinite number of other definitions). Which definition is correct, of course, cannot be decided by gathering facts or doing experiments — indeed *which ethical framework one adopts will in fact determine the shape of science studying animal welfare!*

To clarify: suppose you hold the view that an animal is well-off when it is productive, as per the CAST Report. The role of your welfare science in this case will be to study what feed, bedding, temperature, and so on, are most efficient at producing the most meat, milk, or eggs for the least money — much what animal and veterinary sciences do today. On the other hand, if you take the Farm Animal Welfare Council view of welfare, your efficiency will be constrained by the need to acknowledge the animals' natural behavior and mental state, and to assure that there is minimal pain, fear, distress, and discomfort — not factors in the CAST view of welfare unless they have a negative impact on economic productivity. Thus, in a real sense, sound science does not determine your concept of welfare; rather, your concept of welfare determines what counts as sound science!

The failure to recognize the inescapable ethical component in the concept of animal welfare leads inexorably to those holding different ethical views talking past each other. Thus, producers ignore questions of animal pain, fear, distress, confinement, truncated mobility, bad air quality, social isolation, and impoverished environment unless any of these factors impacts negatively on the “bottom line.” Animal advocates, on the other hand, give such factors primacy, and are totally unimpressed with how efficient or productive the system may be.

A major question obviously arises here. If the notion of animal welfare is inseparable from ethical components, and people's ethical stance on obligations to farm animals differ markedly across a highly diverse spectrum, whose ethic is to predominate and define, in law or regulation, what counts as “animal welfare?” This is of great concern to the agriculture industry, worrying as they do about “vegetarian activists hell-bent on abolishing meat.” In actual fact, of course, such concern is misplaced, for the chance of such an extremely radical thing's happening is vanishingly small. By and large, however, the ethic adopted in society reflects a societal consensus, what most people either believe to be right and wrong or are willing to accept upon reflection.

All of us have our own personal ethics which rule a goodly portion of our lives. Fundamental questions such as what we

read, what we eat, to whom we give charity, what political and religious beliefs we hold, and myriad others are answered by our personal ethics. These derive from many sources — parents, religious institutions, friends, books, movies, and television. One is certainly entitled to believe ethically, as do some PETA members, that “meat is murder,” that one should be a vegetarian, that it is immoral to use products derived from animal research, and so on.

Clearly, a society, particularly a free society, contains a bewildering array of such personal ethics, with the potential for significant clashes between them. If my personal ethic is based in fundamentalist religious beliefs and yours is based in celebrating the pleasures of the flesh, we are destined to clash, perhaps violently. For this reason, social life cannot function simply by relying on an individual's personal ethics, except perhaps in singularly monolithic cultures where all members share overwhelmingly the same values. One can find examples of something resembling this in small towns in rural farming areas, where there is no need to lock one's doors, remove one's keys from the car, or fear for one's personal safety. But of course such places are few, and probably decreasing in number. In larger communities, the extreme case being New York City or London, one finds a welter of diverse cultures and corresponding diverse personal ethics crammed into a small geographical locus. For this reason alone, as well as to control those whose personal ethic may entail taking advantage of others, a social consensus ethic is required, one which transcends personal ethics. This social consensus ethic is invariably articulated in law, with manifest sanctions for its violation. As societies evolve, different issues emerge, leading to changes in the social ethic.

My claim then, is that beginning roughly in the late 1960s, the treatment of animals has moved from being a paradigmatic example of personal ethics to ever-increasingly falling within the purview of societal ethics and law.

Exactly the same logic holds regarding euthanasia. The concept of a “good death” is inherently valuational in general and a matter of ethics in particular. Thus we must look to our current societal ethic for animal treatment to grasp what society expects of euthanasia.

I have done a great deal of writing explicating the emerging social ethic for animals since 1980, and many of my predictions (for example, of legislative pro-animal referenda) have come to pass. In bare bones, the ethic for animals has moved beyond the traditional anti-cruelty ethic and laws that prohibit deliberate, sadistic, willful, intentional infliction of pain and suffering on animals, or outrageous neglect. The point of that ethic was largely to ferret out sadists and psychopaths who begin with animals and “graduate” to people. (Animal abuse by children is sentinel behavior for subsequent psychopathy.) Nothing involved in “ministering to the necessities of man,” or that is standard industry practice can count as cruelty. That in turn means that only a tiny amount of animal suffering is capturable by the anti-cruelty ethic — over 99% of animals' suffering is the result of normal and decent motivations advancing knowledge, supplying cheap and plentiful food, making a legal profit. All the suffering that animals experience in research and agriculture, for example, is immune to the anti-cruelty ethics and laws.

It is for this reason that we have seen a proliferation of laws and proposed laws pertaining to animal welfare in areas traditionally exempt from anti-cruelty laws. The 1985 laws for laboratory animals, which I helped draft, represented a watershed in this regard, since it became mandatory to control pain and distress, something the research community had not done before. In a 1982 literature search on laboratory animal analgesia, I was unable to find papers on the topic. Today there are thousands.

The new ethic demands legislatively encoded guarantees that animals not suffer pain or distress, and live under conditions approximating what their biological and psychological natures demand. As Dale Schwindaman, head of the United States Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS), said to me when the laboratory animal laws passed, "we have just witnessed the birth of some legally encoded rights for animals," though technically animals remain property. In 2004, 2100 laws were proposed regarding animal welfare across the US, and the momentum for farm animal protection illustrates our point.

This societal ethic should determine how we think about euthanasia. Historically, and not that long ago, "euthanasia" was accomplished in many ways unthinkable today: curariform drugs, strychnine, use of car exhaust, bludgeoning, drowning, electro-shock, suffocating birds using thoracic compression (crushing the chest) thereby suffocating them, some of which were accepted by the AVMA and some of which are still accepted, as we shall see.

The best succinct encapsulation of social-ethical requirements for euthanasia may be found in the Canadian Council on Animal Care (CCAC) module, "Euthanasia of Experimental Animals" (4).

"The humane killing of animals requires knowledge, skill, respect for the animal, and an understanding of the many factors that are part of choosing a humane method. The primary welfare principles for a humane method of killing an animal require that there should be very rapid (immediate) unconsciousness and subsequent death and there should be no pain or distress accompanying the procedure."

We will call this statement the Welfare Principle. Since the CCAC represents the opinions of scientists and veterinarians using animals, this statement cannot be viewed as utopian, though it is in fact violated in CCAC's allowing of CO₂ euthanasia, and in other ways.

Clearly the main ethical points of the statement are immediacy of loss of consciousness and the absence of pain and distress in the process of euthanasia. These are the primary values that should guide choice of method. There are, however, secondary values which, while not as weighty, are relevant to choosing euthanasia methods.

Practicality

The "gold standard" for euthanasia of all mammalian species is probably barbiturate injection after sedation and placement of a catheter. Having witnessed this many times, I can attest to its humaneness. Most US humane societies now use it, and virtually all veterinarians. This notwithstanding, it would be practically

impossible to do this in a research setting, where it may be necessary to kill 1000 mice at one time. Similarly, it could not be used for slaughter because it is too time-consuming, and even more importantly, because it would render the carcass inedible. Thus, such euthanasia may be problematic for a horse if the animal is to be placed in a landfill, where scavengers may eat the meat and ingest the barbiturates. Eagles have been killed by such carcasses.

Psychological effect on the operator

In normal people, prolonged periods of killing animals, even when necessary (as in the case of disease outbreak) can have a profound and negative psychological effect. In technicians, researchers, laboratory animal veterinarians or humane society or shelter personnel, killing can create what I have called "moral stress" arising from the paradox that those who care a great deal about animals, and who sometimes chose their job out of a desire to help animals, end up in an assembly line of killing. This often creates both physical and psychological distress, the onset of psychogenic afflictions such as asthma and irritable bowel, substance abuse, alienation from family, and job dissatisfaction. (Even the sadists of the Nazi killing machine were so affected.) While some of this is inevitable, some methods are better than others, and obviously the methods most gentle for the animal create the least stress. When improper high-altitude chambers were used in humane societies, intra-nasal and intra-ocular pressure in young animals suffering from infections could cause bleeding from eyes, nose, and ears, with both the animals and workers suffering. Similarly, the actual slaughterers in slaughterhouses are often seen as "scary" by the other workers, are shunned by them, and tend to interact primarily with each other. Clearly, the bloodier a method of killing, the more problematic in this regard it becomes.

Effect on observers

This is a continuation of the previous category, and concerns situations where animals must be euthanized in public, for example, injured horses after a traffic accident. This value may conflict with the issue of humaneness of euthanasia. I encountered a vivid example in another country, where I was meeting with the officials of their equine association and asked how they kill injured horses at the track. They replied that they used to use gunshot, but the blood "upset the public," so they now injected succinylcholine chloride and the animal "peacefully went to sleep." Appalled, I realized that they did not realize that the drug is a paralytic, and that the death was an agonizing one through suffocation!

Ease of using the method

Cervical dislocation, for example, or use of a captive bolt, requires a fair amount of skill to be done properly, and should thus never be assigned to an untrained person.

All of these values may interact in different ways in different situations. The key point is that primacy should always be given to the comfort of the animal. Thus "ease" may be viewed as part of humaneness, separable only conceptually.

Though much progress has been made in elimination of improper methods, some still endure, largely because

convenience has trumped concern for the animal. Some of these violate the primary humane directive; others create untoward aesthetic effects on observers; some are still done though condemned by AVMA euthanasia guidelines, a document explicitly part of federal law regarding animal research. Equally problematic is the fact that the AVMA guidelines are internally inconsistent.

Let us look at some killing modalities accepted by the AVMA guidelines, but which clearly violate our principal animal welfare criterion. A very obvious example is thoracic compression. This method was historically considered the method of choice for birds that need to be killed in field research (5). In the AVMA euthanasia guidelines of 2007 (6) (the most recent), thoracic compression is listed as “conditionally acceptable” and described as causing “hypoxia and cardiac arrest,” as being “moderately rapid,” as useful for “small to medium-sized free-ranging birds,” and “apparently effective” and requiring training. What is thoracic compression? Essentially crushing the bird’s chest in one’s hand! Death occurs through suffocation and resulting “physical interference with cardiac and respiratory function.” This is surely painful, distressing, slow and inhumane, and violates our primary principle; yet it is allowed. Further, the AVMA disallows suffocation (“smothering” of newly hatched chicks) in bags, widely practiced historically in the poultry industry. If anything, thoracic compression seems at best not different or even much worse because of possible fractures.

A similar point can be made regarding the CO₂-filled foam that the AVMA allows for “depopulating” chicken houses that have infected animals. The foam is blown into the house so it covers the animals, asphyxiating or suffocating them, resulting in hypoxia and death. Why is this allowed? It surely violates the welfare principle. In all of the above instances, it is plain that human convenience trumps the welfare principle. Yet by the reasoning we detailed above, the welfare consideration should be paramount!

Also problematic is the AVMA guidelines position on decapitation. Decapitation is often required, or at least seen as ideal, for certain neuroscience or nutrition studies that want to study brain chemistry unaffected by drugs. Historically, the 1993 guidelines saw decapitation as problematic because of the persistence of brain activity for a relatively long time after the severing of the head. Some research confirmed this point, as did anecdotal accounts from the French Revolution of heads blinking in a signaling way after a person was decapitated by the guillotine. Thus the 1993 AVMA Euthanasia Panel required either anesthesia or immediate dropping of the head in liquid nitrogen to stop all processes. So vocal was scientists’ opposition, with the researchers defending the claim that no pain could be felt after decapitation, that the AVMA backed down and allowed decapitation with no qualifiers, citing more recent studies allegedly showing that the decapitated animal could not perceive pain. Of course we don’t know what the animals feels, and it is possible that much pain is felt, or significant distress, which the Federal law also mandates should be controlled. Further, if AVMA guidelines are correct, and electrical activity persists for “13 to 14 seconds following decapitation [actually much longer time has been reported] and there is consciousness”

(7), the death is far from instantaneous. Interestingly enough, the USDA originally demanded something like the Welfare Principle, that is, instantaneous loss of consciousness, but in 1989 retreated to “rapid loss of consciousness,” and thus itself violates the welfare principle.

This discussion leads me to draw an ethical/welfare logical corollary from the Welfare Principle: In the absence of certainty about animal pain and distress, the animals should be given the benefit of the doubt. [This principle is similar to the Precautionary Principle found in EU law regarding possible harm to the public or to the environment, and explains European opposition to genetically modified organisms (GMOs)]. What this means in regard to decapitation is that the policy of no decapitation without anesthesia or immediate immersion of the head in liquid nitrogen is more reasonable than the current stance.

All of this leads to what is, in my mind, the most egregious ethical mistake in the AVMA Euthanasia Guidelines — that is the acceptance of CO₂ as a method of “euthanasia” applied to millions of rodents. In my 30 years as an ombudsman for animals at Colorado State University, I have received more complaints about CO₂ killing than any other issue. Technicians and some researchers are greatly upset by the degree to which rats and mice struggle and attempt to climb out of the box where CO₂ is administered. And this is no surprise to anyone knowing the rudiments of respiratory physiology. Carbon dioxide drives respiration, so breathing CO₂ while conscious must feel something like asthma, or being held under water — consider the effectiveness of waterboarding. And it is noteworthy that emergency rooms take asthmatics as soon as they come in — so great is the panic associated with feeling like one “cannot breathe” even among those who know what is going on. As an asthmatic, I would describe the sensation as bad as any pain I ever had. Furthermore, CO₂ forms carbonic acid on mucus membranes, adding further irritation. And we know that breathing CO₂ is highly aversive to humans — if any of you doubt me, take a whiff of dry ice!

Furthermore, the time to unconsciousness can be 30 seconds or more — a far cry from instantaneous and a very long time to be in agony. At the root of my and many others’ aversion to CO₂ is the ethical judgment that seconds of suffocation cannot reasonably be called a good death, though supporters of CO₂ argue that it is “only seconds.” This shows that the debate is not primarily scientific, but at root ethical.

In consulting the scientific literature on CO₂, I found no scientific consensus on most aspects of CO₂ euthanasia — rate of filling the chamber, concentration, signs of aversiveness, and so on. I suspect that is because people see data in accordance with their theoretical presuppositions and expectations. Adams has suggested some possible reasons for lack of agreement (8). In my view, CO₂ advocates see the good — CO₂ opponents the bad. This is not the place for a technical review of the literature, nor for an attempt to reconcile what I think are probably irreconcilable differences, despite the fact that all parties are doing “science.” But it is appropriate for me to chronicle what has shaped my own thinking with regard to this issue. This is best summarized by Raj et al (9):

"The results of experiments on several laboratory and farm animal species have shown that carbon dioxide is aversive to a far greater extent than other commonly used gaseous agents such as halothane, sevoflurane, desflurane, and isoflurane whether used alone or in combination with other gases. Moreover, aversion is observed to varying degrees regardless of whether carbon dioxide is presented in a pre-filled chamber, as a rising concentration, humidified, or combined with an inert gas or oxygen. There is also evidence to suggest that, in addition to aversion, animals unable to escape from an environment containing carbon dioxide are likely to experience considerable pain and distress before loss of consciousness..."

Additionally, trials involving human exposure to CO₂ indicate that it induces a sense of breathlessness prior to loss of consciousness, and 36 out of 40 persons reported adverse sensations at concentrations of 50% (8); a level similar to those used in animal anesthesia and exceeded when CO₂ is used for euthanasia. The sensation of breathlessness or dyspnea in humans is believed to originate from a direct activation of cerebral cortical sensory systems involved with respiration (conscious awareness of efferent motor command corollary discharge). It is also known that dyspnea during inhalation of carbon dioxide is due to activation of vascular chemoreceptors from increases in blood CO₂ levels (hypercapnea) and results in increased respiratory motor activity. It is worth noting that hypercapnea is a more potent respiratory stimulant than hypoxia or anoxia. It is reasonable to assume, based on current understanding of comparative respiratory anatomy and physiology, that laboratory animals also feel these effects experienced by humans.

A related point is made in an earlier paper by Leach et al (10):

"Induction with carbon dioxide either alone or in combination with argon is likely to cause considerable distress before the loss of consciousness in rodents, which is unacceptable considering that effective and more humane alternatives are available."

Indeed. At the Centers for Disease Control in Fort Collins and at Colorado State University, prompted by concern for animal suffering during CO₂ euthanasia, we are moving to prior exposure to isoflurane, which is less abusive, to create unconsciousness prior to CO₂ euthanasia. Some people suggest that introducing CO₂ at the rate of 20% per minute leads to unconsciousness without apparent distress. That may well be. But since we lack sophistication in knowing subtle indicators of distress or what the animal feels, I would suggest that CO₂ represents a paradigm example of where the Precautionary Principle of the benefit of the doubt being given to the animals' welfare ought to apply. When we don't know, we should give the animal the benefit of the doubt!

These considerations led me to look for a more humane method for euthanizing small rodents and, with the help of wonderful, equally concerned colleagues in a variety of fields, we began to investigate creating hypoxia (brain death) without asphyxia or suffocation. We began to study hypobaric hypoxia. The basis for my idea was old World War II movies where a pilot flies too high without oxygen and "blacks out." This led me to look at the US Air Force Web site.

Hypoxia (loss of oxygen to the brain) is a potential problem for pilots, so all pilots must, as part of their training, experience high-altitude loss of oxygen pressure in a chamber. They report a dissolution of consciousness and a pleasant euphoria equivalent to ingesting 6 ounces of alcohol, before going unconscious, which I confirmed with former pilots. We also possess notebooks of late 18th-century French balloonists who ascended to great heights, wrote of the pleasantness of the experience, and said they planned to go higher, did so, and expired. Knowing that high altitude hypoxia had been used prior to the 1980s for euthanasia in pounds and shelters and that that had been disastrous because defective equipment lead to depressurization and repressurization as a result of leakage, and to suffering in animals with naso-pharyngeal infection, we started from scratch. With the help of a number of mechanical engineers, we built a precise, computer-controlled, leak-proof chamber. We then tested it on rats and mice that showed no signs of pain or distress, merely a period of excitation (described by some as "popcorn mice") before falling asleep. Best of all, we saw no sign of respiratory distress or escape behavior. We are currently having the device tested at a major medical school to get physiological evidence supporting our observations.

To recapitulate: What are the best modes of euthanasia? Like any animal welfare issue, is not simply a question to be answered by science, but has an irreducible ethical component. Reflection on the ethics reveals that there are many methods accepted as providing a good death, but that do not seem to do so. The challenge to animal researchers is to create methods that provide a good death, giving the benefit of the doubt to animals. At the moment, it appears that some of what is accepted as "euthanasia" is not in fact, a "good death," being driven more by political considerations than humane ones.

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